Appendix C -

Sizing Methods

Hydrologic Analysis and Stormwater Control Measure Sizing Guidance

Project site conditions will influence the ability to comply with the Water Quality Treatment and Runoff Retention Performance Requirements. This Appendix provides the acceptable hydrologic analysis and Stormwater Control Measure (SCM) sizing methodology to evaluate runoff characteristics. This guidance provides an event-based hydrologic analysis approach. Calculations are conservative to acknowledge the limitations of event-based approaches. Using an event-based approach avoids the necessity of using calibrated, continuous simulation modeling. The project applicant may use a locally/regionally calibrated continuous simulation-based model to improve hydrologic analysis and SCM sizing.

1) Determination of Retention Tributary Area

Determining the Retention Tributary Area is the basis for calculating the runoff volumes subject to Performance Requirement Number 3. Retention Tributary Area should be calculated for each individual Drainage Management Area (DMA) to facilitate the design of SCMs for each DMA. The generic equation below illustrates how various portions of the site are addressed when determining the Retention Tributary Area. The Retention Tributary Area calculation must also account for the adjustments for Redevelopment Projects subject to Performance Requirement No. 3.

a) Compute the Retention Tributary Area, using the equation:

Retention Tributary Area = (Entire Project Area) – (Undisturbed or Planted Areas) – (Impervious Surface Areas that Discharge to Infiltrating Areas)***

* As defined in Section B.4.d.iv.1.

** As defined in Section B.4.d.iv.2.

b) Adjustments for Redevelopment Project Retention Tributary Area – Where the Project includes replaced impervious surface, the following Retention Tributary Area adjustments apply:

i) Redevelopment Projects outside an approved Urban Sustainability Area, as described in the Alternative Compliance section – The total amount of replaced impervious surface area shall be multiplied by 0.5 when calculating the Tributary Area.

ii) Redevelopment Projects located within an approved Urban Sustainability Area – The replaced impervious surface areas may be subtracted from the Retention Tributary Area. The total amount of runoff volume to be retained from replaced impervious surfaces shall be equivalent to the pre-project runoff volume retained.

2) Determination of Retention Volume

a) Based on the Regulated Project's Watershed Management Zone, determine the Regulated Project's Runoff Retention Requirement (e.g., Retain 95th Percentile 24-hour Rainfall Event, or, Retain 85th Percentile 24-hour Rainfall Event). See **Appendix A** for rainfall depth.

b) Determine the 85th or 95th percentile 24-hour rainfall event:
Use either the methodology provided in Part I.D of the December 2009 Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of

the Energy Independence and Security Act,[1] or, rainfall statistics provided by the Central Coast Water Board, whichever produces a more accurate value for rainfall depth.

c) Compute the Runoff Coefficient[2] "C" for the area tributary to the SCMs, using the equation:
$C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04$ (As alternative a weighted "C" per H-3, H-3a of County Standards may be used)

Where "i" is the fraction of the tributary area that is impervious[3]

d) Compute Retention Volume:

Retention Volume for 95th Percentile 24-hr Rainfall Depth = C x Rainfall $Depth_{95th}$ x Tributary Area

Retention Volume for 85th Percentile 24-hr Rainfall Depth = C x Rainfall $Depth_{85th}$ x Tributary Area

All rainfall directly incident to each SCM must be considered in determining runoff, including: tributary landscaping, impervious areas, pervious pavements, and bioretention features.

e) Calculate SCM Capture Volume:
Calculate the required SCM Capture Volume associated with the Regulated Project's Runoff Retention Requirement by one of the following methods:

Method 1: Simple Method

SCM Capture Volume = Retention Volume for 95th Percentile 24-hr Rainfall Depth

or,

SCM Capture Volume = Retention Volume for 85th Percentile 24-hr Rainfall Depth

Method 2: Routing Method

Use a hydrograph analysis[4] to determine the SCM Capture Volume needed to retain the Retention Volume for 95th or 85th Percentile 24-hr Rainfall Depth calculated in 2 (above). The SCM Capture Volume shall be based on both the rate of flow from tributary areas into the SCM, and the rate of flow out of the SCM through infiltration into the underlying soil during the rain event. When conducting the hydrograph analysis, adhere to the criteria included in Table 1. The SCM shall be designed such that a single 95th or 85th Percentile 24-hr Rainfall Event will not overflow the SCM.

[1] USEPA, 841-B-09-00. http://www.epa.gov/owow/NPS/lid/section438/pdf/final_sec438_eisa.pdf
[2] As set forth in WEF Manual of Practice No. 23/ASCE Manual of Practice No. 87, (1998), pages 175-178 and based on the translation of rainfall to runoff using a runoff regression equation developed using two years of data from more than 60 urban watersheds nationwide.
[3] As defined in Post-Construction Requirements Appendix C.
[4] HydroCAD is an example of a commonly used and widely accepted program for performing hydrograph analyses and design of stormwater infrastructure. HydroCAD is based on U.S. Department of Agriculture Soil Conservation Service's (now Natural Resources Conservation Service) TR-55: Urban Hydrology for Small Watersheds.

If the Retention Volume cannot infiltrate within 48-hours, a multiplier of 1.20 shall be applied to the SCM Capture Volume calculated through the routing method.

TABLE 1: Routing Method Criteria

Parameter	Criteria
Hydrograph Analysis Method	National Resources Conservation Service or Santa Barbara Urban Hydrograph
Pond Routing Method	Storage-indication, unless otherwise justified to be more correct based on site and storage conditions.
Infiltration Rate	Underlying soil saturated infiltration rate, as indicated by locally accepted data approved by the Permittee and/or by on-site testing, whichever is more accurate.
Rainfall Distribution	National Resources Conservation Service Type I[5] or based on local rainfall data
Time of Concentration	Permittee's current drainage and flood control standard
Time Increment	0.10 hour, unless otherwise justified to be more correct based on rainfall distribution

Note: For redevelopment projects located within an approved Urban Sustainability Area the total amount of runoff volume to be retained from replaced impervious surfaces shall be equivalent to the pre-project runoff volume retained.

3) Structural Stormwater Control Measure Sizing

The Project Engineer shall use structural SCMs that optimize retention and result in optimal protection and restoration of watershed processes, such as Structural Control Measures associated with small-scale, decentralized facilities designed to infiltrate evapotranspirate, filter, or capture and use stormwater, to address the volumes calculated in 2 (above). Where the Project is within a Watershed Management Zone where infiltration is required, the project design must use SCM designs that optimize infiltration of the entire Retention Volume to minimize the potential need for off-site mitigation. Various resources provide design guidance for fully infiltrative SCMs including:

- The Contra Costa C.3 Manual
- The City of Santa Barbara LID BMP Manual
- The City of San Diego LID Design Manual
- Central Coast LID Initiative Bioretention Design Guidance

[5] The National Resources Conservation Service developed standard 24-hour rainfall distributions for hydrograph analyses. These rainfall distributions were intended to represent intensities associated with shorter duration storms, ranging from durations of 30 minutes to 12 hours. The National Resources Conservation Service Type 1 storm applies to the California West Coast, including the Central Coast Region. The Type 1 rainfall distribution was derived using National Oceanic Atmospheric Administration Atlas 2 rainfall statistics for the 1-year through 100-year storm.

Per Resolution No. R3-2013-0032 the maximum surface loading rate appropriate to prevent erosion, scour and channeling within the bio-filtration treatment system itself and equal to 5 inches per hour, based on the flow of runoff produced from a rain event equal to or at least 0.2 inches per hour. Thus the ratio of tributary impervious area to bio-filtration surface area needs to be: 0.2 inches per hour / 5 inches per hour =0.04.

a) Demonstration of Compliance – Require Regulated Projects to demonstrate that site SCMs: a) will infiltrate and/or evapotranspirate the Retention Volume or, b) will provide sufficient Capture Volume to retain the Retention Volume. Any outlet (i.e., underdrain) installed in a structural SCM shall be installed above the elevation of any portion of the structural SCM dedicated to Retention Volume storage.

b) Compliance with Water Quality Treatment Performance Requirement – Require Regulated Projects that propose to use the retention-based structural Stormwater Control Measures to also meet the Water Quality Treatment Performance Requirement, to demonstrate, in the Stormwater Control Plan, that the Water Quality Treatment Performance Requirement is being fully met.

Runoff Factors for Self-Retaining Areas

The following information is excerpted from the *C.3 Stormwater Handbook* (February 12, 2012 – 6th Edition):

Runoff from impervious or partially pervious areas can be managed by routing it to self-retaining pervious areas. For example, roof downspouts can be directed to lawns, and driveways can be sloped toward landscaped areas. The maximum ration is 2 parts impervious area for every 1 part pervious area if only treatment requirements apply to the development project. If flow-control requirements also apply, the maximum ration is 1 part impervious area for every 1 part pervious area.

The drainage from the impervious area must be directed to and dispersed within the pervious area, and the entire area must be designed to retain an inch of rainfall without flowing off-site. For example, if the maximum ratio of 2 parts impervious area into 1 part pervious area is used, then the pervious area must absorb 3 inches of water over its surface before overflowing to an off-site drain.

A partially pervious area may be drained to a self-retaining area. For example, a driveway composed of unit pavers may drain to an adjacent lawn. In this case, the maximum ratios are, for treatment-only site:

$$\text{(runoff factor)} \times \text{(tributary area)} \leq 2 \times \text{(self-retaining area)}$$

For sites subject to flow-control requirements:

$$\text{(runoff factor)} \times \text{(tributary area)} \leq 1 \times \text{(self-retaining area)}$$

Use the runoff factors in [Table 2].

Prolonged ponding is a potential problem at higher impervious/pervious ratios. In your design, ensure that the pervious area soils can handle the additional run-on and are sufficiently well-drained.

Runoff from self-treating and self-retaining areas does not require any further treatment or flow control. Further, there is no requirement for operation and maintenance inspections.

Table 2: Runoff Factors		
Surface	**PR # 2 and #3 Treatment and Flow Control**	**PR #2 Treatment Only**
Roofs	1.0	1.0
Concrete or Asphalt	1.0	1.0
Pervious Concrete	0.1	0.1
Porous Asphalt	0.1	0.1
Grouted Unit Pavers	1.0	1.0
Solid Unit Pavers Set in Sand	0.5	0.2
Crushed Aggregate	0.1	0.1
Turfblock	0.1	0.1
Landscape, Group A Soil	0.1	0.1
Landscape, Group B Soil	0.3	0.1
Landscape, Group C Soil	0.5	0.1
Landscape, Group D Soil	0.7	0.1